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AQUATIC PLANTS FOR REMOVAL OF MEVINPHOS FROM THE AQUATIC ENVIRONMENT

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16. ABSTRACT <p>Fragrant waterlily (<u>Nymphaea odorata</u>, Ait.), joint-grass (<u>Paspalum distichum</u> L.), and rush (<u>Juncus repens</u>, Michx.) were used to evaluate the effectiveness of vascular aquatic plants in removing the insecticide mevinphos (dimethyl-1-carbomethoxy-1propen-2-yl phosphate) from waters contaminated with this chemical.</p> <p>The emerged aquatic plants fragrant waterlily and joint-grass removed 87 and 93 ppm of mevinphos from water test systems in less than 2 weeks without apparent damage to the plants; whereas rush, a submersed plant, removed less insecticide than the water-soil controls. Water-soil controls still contained toxic levels of this insecticide, as demonstrated by fish bioassay studies, after 35 days.</p> <p style="text-align: center;">EDITOR'S NOTE</p> <p>Use of trade names or names of manufacturers in this report does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the National Aeronautics and Space Administration or any other agency of the United States Government.</p>		
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INTRODUCTION

During the past few years, environmentalists have been taking a close look at the levels and distribution of pesticides, heavy metals, and other hazardous chemicals in our environment. The increased chemical waste disposal at the National Aeronautics and Space Administration's (NASA) National Space Technology Laboratories creates the need for a better understanding of the part vascular aquatic plants play in removing pesticides and other hazardous chemicals from polluted waters. Vascular aquatic plants are also potential sensors which can possibly be used to monitor the quality of water in which they grow by means of remote sensing.

The fact that vascular plants can absorb, translocate, and metabolize various chemicals has been used to great advantage by entomologists in controlling plant-eating insects. Insecticides that are capable of being absorbed and translocated in plants are known as systemic insecticides. The phenomenon involved in systemic uptake, translocation, concentration and/or metabolic breakdown of pesticides from soil should be taken advantage of in such important applications as removing chemicals from polluted waters. Experiments have demonstrated that the absorption of insecticides by plant roots from various media is greater from solution than from soil (1).

Recent experiments have also shown that while no cadmium was demonstrated in corn and turnip leaves grown in soil fertilized with superphosphate containing 7.25 ppm cadmium, these same plants grown in aqueous solutions containing 0.1 ppm cadmium concentrated 90 and 160 ppm of cadmium in their leaves (2, 3). Recent research has also demonstrated the ability of aquatic plants to assimilate nutrients and remove excess nitrates and phosphates from sewage effluent (4, 5). A system utilizing vascular aquatic plants to remove nutrients from sewage effluent is presently being evaluated on a large scale by the Institute of Water Research (IWR) at Michigan State University (6).

Pollution abatement studies are also being conducted at NASA's National Space Technology Laboratories (NSTL) directed toward utilizing vascular aquatic plants to remove heavy metals and other chemicals from photographic and chemical laboratory waste waters.

MATERIALS AND METHODS

The technical-grade Mevinphos used in this study was obtained from the Shell Chemical Company. The water, soil, and vegetation used in the experiments were obtained from Timberlake Pond (fresh water) or near an inlet of Choctawhatchee Bay (brackish water, salinity 1.5 percent), both on the Eglin Air Force Base, Florida, reservation.

Glass cylinders with a capacity of 0.015 m³ (15 liters) were placed in a greenhouse with an average maximum daytime temperature of 30° C and an average minimum night temperature of 23° C. The cylinders were filled with either fresh water or brackish water. Soil from the same areas was added to the cylinders to a depth of from 5 to 7 cm. Rush and fragrant water lily were both planted in three cylinders of fresh water and joint-grass in three cylinders each of both fresh and brackish water. Control cylinders contained water, soil, and Mevinphos.

After several weeks of acclimation in the greenhouse, 70 to 96 ppm of Mevinphos were added to each cylinder. Water samples from each cylinder and pH readings were taken at various time intervals during a 35-day period after treatment. Distilled water was added periodically to replace water that was lost through evaporation.

ULTRAVIOLET SPECTROPHOTOMETRIC ANALYSIS

Water samples containing Mevinphos were analyzed with a Beckman DK-2A ratio recording spectrophotometer using silica cells. When Mevinphos concentrations exceeded 15 ppm, dilutions were made with distilled water. A Mevinphos-free solution containing the same mixture of lake water or brackish water and distilled water as the samples was used in the reference cell. The ultraviolet absorption peaks for Mevinphos were linear at a wavelength of 217 μ m and the detection limit was less than 1 ppm. A standard concentration curve was prepared using 1, 2, 3, 5, 10, and 15 ppm of Mevinphos dissolved in distilled water. The peak height from the samples was compared with a standard curve to determine Mevinphos concentrations.

FISH TOXICITY STUDIES

Fish bioassay studies were conducted to verify ultraviolet spectrophotometric data. Mosquitofish (Gambusia affinis), seined from ponds and streams on the Eglin Air Force Base Reservation, were used as the test species. The fish, having a total length of 20 to 30 mm, were acclimated in the laboratory in $37.85 \times 10^{-3} - m^3$ (10-gal) holding tanks for a minimum of 10 days before they were used. Water temperatures were maintained at approximately 22° C. Test containers were $0.001 - m^3$ (1-liter) beakers, each housing 10 fish. The fish were placed in the test water and observed for 24 hr. Data were taken on the number of fish alive after various time intervals.

RESULTS AND DISCUSSION

Ultraviolet spectrophotometric data demonstrated that joint-grass and fragrant water lily were capable of removing from 87 to 93 ppm of Mevinphos from water test systems in less than 2 weeks without apparent damage to the plants, whereas rush removed less insecticide than the water plus soil controls. Water controls contained averages of 43 and 58 ppm of Mevinphos, whereas water plus soil controls contained averages of only 4 and 5 ppm after 35 days (Table 1).

Bioassay data demonstrated the effectiveness of joint-grass and fragrant water lily in removing from 87 to 93 ppm of Mevinphos and/or any products toxic to mosquitofish from experimental water in less than 2 weeks, thus confirming the ultraviolet spectrophotometric data (Table 2).

The filtering capability of aquatic plants appears to be dependent on the active participation of the plant in four main processes; namely, absorption, translocation, concentration, and detoxification (metabolic breakdown). Emerged aquatic plants appear to be more effective in removing mevinphos from aqueous solution than submersed species. This might be explained by the fact that the emerged plants transpire considerable amounts of water through their leaves behaving much like a wick.

TABLE 1. MEVINPHOS CONCENTRATION IN FRESH AND BRACKISH WATER (in parts per million)
CONTAINING VARIOUS AQUATIC PLANTS

Contents of Cylinders ^a	Time (days)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	27	35
Brackish-Water Controls	89	86	73	69	- ^b	-	-	61	53	-	-	43	-	41	47	43
Fresh-Water Controls	96	93	91	88	87	85	83	82	82	81	81	81	80	80	71	58
Fresh-Water and Soil Controls	94	86	-	-	46	-	-	31	25	-	-	18	-	13	5	4
Brackish-Water and Soil Controls	84	65	-	-	55	-	-	41	32	-	-	24	-	20	6	5
<u>Nymphaea odorata</u> , Ait	93	78	61	41	33	22	14	9	7	4	-	1	0	0	0	0
<u>Juncus repens</u> , Michx.	98	91	86	80	79	76	64	60	58	55	-	51	47	44	11	-
<u>Paspalum distichum</u> L.	87	70	57	46	40	31	24	18	13	9	-	2	1	0	0	0
<u>Paspalum distichum</u> L. (Brackish Water)	70	33	-	-	20	-	-	8	0	0	0	0	0	0	0	0

a. Values are averages from three replications.

b. A dash (-) indicates data were not collected at these time periods.

TABLE 2. MOSQUITOFISH (*Gambusia affinis*) BIOASSAY
OF EXPERIMENTAL MEVINPHOS SOLUTIONS

12th-Day Bioassay ^a	Number of Test Fish Surviving					
	5 min.	10 min.	1 hr	2 hr	4 hr	24 hr
Control	10	10	10	10	10	10
Fresh Water Only	0	0	0	0	0	0
Brackish Water Only	0	0	0	0	0	0
<u>Nymphaea odorata</u> , Ait.	10	10	10	9	9	9
<u>Juncus repens</u> , Michx.	6	1	0	0	0	0
<u>Paspalum distichum</u> L.	10	10	10	10	10	10
<u>Paspalum distichum</u> L. (Brackish Water)	10	10	10	10	10	10
Mevinphos — Water Control	6	0	0	0	0	0
Fresh Water and Soil	0	0	0	0	0	0
Brackish Water and Soil	10	0	0	0	0	0
27th-Day Bioassay ^b						
Control	10	10	10	10	10	10
Fresh Water Only	0	0	0	0	0	0
Brackish Water Only	0	0	0	0	0	0

TABLE 2. (Concluded)

27th-Day Bioassay ^b	Number of Test Fish Surviving					
	5 min.	10 min.	1 hr	2 hr	4 hr	24 hr
<u>Juncus repens</u> , Michx.	10	10	0	0	0	0
Mevinphos — Water Control	5	0	0	0	0	0
Fresh Water and Soil	10	10	10	0	0	0
Brackish Water and Soil	10	10	10	0	0	0
35th-Day Bioassay ^b						
Control	10	10	10	10	10	10
Fresh Water Only	0	0	0	0	0	0
Brackish Water Only	0	0	0	0	0	0
<u>Juncus repens</u> , Michx.	10	10	5	2	0	0
Mevinphos — Water Control	10	1	0	0	0	0
Fresh Water and Soil	10	10	10	9	8	0
Brackish Water and Soil	10	10	10	8	8	0

a. Values are average from three experiments.

b. Treatments that resulted in no fish deaths at the 12th-day bioassay were not done in this test.

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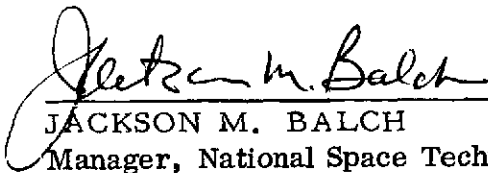
APPROVAL

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The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the NSTL Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.



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